Patients with End-stage Knee Osteoarthritis who Walk with a Faster Self-selected Speed in the Pre-operative Period Engage in More and Higher Intensity Daily Physical Activity.

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INTRODUCTION: In the pre-operative period, patients with knee OA awaiting knee arthroplasty surgery have high levels of joint pain [1], which can result in their adoption of walking mechanics characterized by knee joint stiffness [2]. Ultimately, poor joint mobility and function along with clinical symptoms may limit patients in engaging in physical and social activities, therefore hindering their ability to achieve daily physical activity (PA) targets. Unexpectedly, following TKA, most patients PA levels remain unchanged or decrease, generally staying below healthy age-matched controls [3,4]. Understanding the potentially complex relationships between gait mechanics, pain and PA levels in arthroplasty patients may allow clinicians to make more informed decisions to improve patient engagement and quality of life. The objective of this study was to examine the associations between PA, knee joint gait kinematics, and pain scores in patients with end-stage knee OA prior to TKA surgery. We hypothesized that patients with more symptomatic gait kinematics would be less physically active in the pre-operative period and report higher pain levels than those with higher range of knee joint motion during walking.

METHODS: Following NSH Research Ethics Board approval, patients with end-stage knee OA on the waitlist for arthroplasty were recruited and provided informed written consent to participate. At a pre-operative clinical visit, an inertial measurement unit (IMU) sensor (AX6, Axivity) was anatomically aligned to the tibia of their OA-affected limb and fixed with a waterproof medical adhesive tape for one week to monitor their in vivo activity. A custom MATLAB script was developed using mean amplitude deviation calculations, a type of PA intensity classification algorithm [5] to define average daily step counts, and percentages of time spent sedentary, doing light PA (LPA), and doing moderate-to-vigorous PA (MVPA). A 10 camera (Sony RXO II) markerless motion capture system (Theia3D Markerless) was used to capture and model the 3D limb segment poses during walking, which were used to define stride characteristics and 3D joint kinematics defined according to the joint coordinate system in Visual3D (C-motion). The Oxford Knee Score Pain Component Score (OKS-PCS) questionnaire [6] was collected to classify self-reported pain levels. Pearson's correlation analyses were used to examine the associations between gait speed, knee flexion and adduction angle ranges of motion (KFROM, KAROM) and averages (meanKF, meanKA) during the stance phase of gait with average daily step count and % sedentary, in LPA and MVPA. Patients were categorized by achieving a target of more or less than 7000 average daily step counts [7] and t-tests were used to examine differences in kinematic gait outcomes, pain scores and BMI between these groups.

RESULTS: There were no significant correlations between knee angle gait outcomes and step count, % sedentary, % LPA or % MVPA. Gait speed was negatively correlated with % sedentary (r=-0.49, p<0.05), and positively correlated with % LPA (r=0.43,p<0.05) and pain scores (r=0.45,p<0.05). Trends were also observed for gait speed with % MVPA (r=0.41,p=0.057) and BMI (r=-0.39,p=0.08). BMI was negatively correlated with step count (r=-0.50,p<0.05) and % MVPA (r=-0.47,p<0.05). Twelve patients achieved more than 7000 average daily steps, ten did not. There were no significant differences between groups in LPA or gait outcomes, but those achieving greater than 7000 steps spent less time sedentary (p<0.05), more time in MVPA (p<0.01) and had lower BMIs (p<0.05) (Table 1).

DISCUSSION: Average self-selected walking speed, lower BMI, and achieving a minimum recommended level of daily activity of 7000 steps was associated with less time spent sedentary and more time in moderate to vigorous activity, suggesting that patients with lower BMI and higher surrogate function, as represented through gait speed, engage in more intense activities of daily living while waiting for arthroplasty surgery. LPA levels did not differ between the groups, which could indicate that the difference between achieving recommended daily levels of PA lies more in whether a patient engages in moderate to vigorous levels of PAs. Having higher pain was associated with lower gait speed, consistent with literature [8], but pain was surprisingly not associated with PA outcomes. Contrary to our hypotheses, having greater range of knee motion during gait was not associated with higher levels of PA or PA intensity during the pre-arthroplasty period. Future work with a larger sample size and more diversity in the recruited population may help in clarifying these findings.

SIGNIFICANCE/CLINICAL RELEVANCE: Having a better understanding of pre-arthroplasty patient PA levels and their relationships with other outcomes may help clinicians make more-informed decisions, recommendations and manage patients' expectations.

REFERENCES: [1] Jordan et al., J Rheumatol. 1997;24:1344–9. [2] Ramadan Hafez et al., Phys Med Rehabil Int. 2014;1(5): 8. [3] Paxton et al., World J Orthop. 2015;18;6(8):614-22. [4] Visserset al., Gait Posture, 2013;38(2);310–315. [5] Vähä-Ypyäet al., Clin Physiol Funct Imaging, 2015;35(1);64-70. [6] Harris et al., Qual Life Res, 2013;22(9);2561-2568. [7] Tudor-Locke et al., IJBNPA, 2011;8;80. [8] Taylor et al., J. Geriatr. Nurs, 2018;39(5);580-583

Table 1: Patient demographic by whether they achieved the recommended daily step count of 7000 steps pre-TKA. Statistically significant differences between groups (p < 0.05) are indicated in the right column by a star. Pain score (OKS-PCS) is defined as 0 = extreme pain, 28 = no pain.

| Variable	Average daily step count < 7000 Mean (stdev)	Average daily step count > 7000 Mean (stdev)
Number of subjects (m, f)	7,5	7,3
BMI (kg/m^2)	25.8 (5.6)	20.9 (3.9)*
Age (years)	69.3 (7.2)	69.3 (5.3)
Daily step count (steps)	3971.9 (1218.7)	8856.3 (1330.6)
Daily time spent sedentary (%)	80.3 (5.1)	74.8 (4.7)*
Daily time spent in LPA (%)	12.4 (3.4)	13.5 (3.2)
Daily time spent in MVPA (%)	7.3 (2.7)	11.7 (2)*
Gait speed (m/s)	1.1 (0.2)	1.1 (0.2)
KFROM (deg)	7.8 (5.6)	8.5 (4.1)
KAROM (deg)	2.2 (1.5)	2.4 (1.4)
meanKF (deg)	13.9 (2.7)	12.9 (5.3)
meanKA (deg)	5 (3.5)	4.1 (3.1)
Pain score	13.8 (4.6)	13 (6.1)
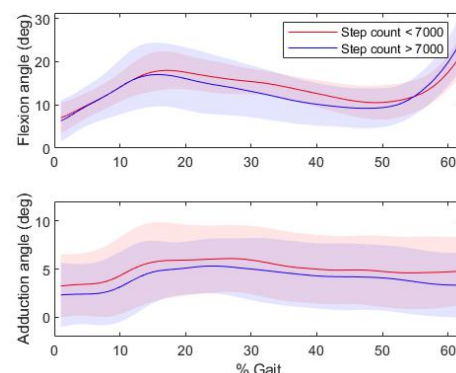
Figure 1: Knee flexion (top) and adduction (bottom) angles during stance phase for participants having achieved 7000 average daily steps or not. KFROM and KAROM were calculated as the difference between the max angle before 20% of the gait cycle and the minimum angle between 20% and toe off.